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**TISSUE-SPECIFIC RESPONSES TO WATER
DEFICIT IN THE NEW ZEALAND
XEROPHYTIC TUSSOCK SPECIES
*Festuca novae-zelandiae***

A Thesis Presented in Partial Fulfilment of the Requirements for the
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ABSTRACT

Festuca novae-zelandiae (Hack.) Cockayne is an endemic New Zealand perennial tussock forming grass of the family Poaceae. Morphologically *F. novae-zelandiae* exhibits a number of leaf adaptations associated with dehydration postponement as reflected in the climatic distribution of this species and its occurrence as a physiognomic dominant grass in semi arid short-tussock grasslands. Biochemical studies into the drought tolerance of this species have indicated the occurrence of tissue specific responses with respect to abscisic acid (ABA) and proline accumulation and protein turnover suggestive of a preferential protection of the tiller base and associated meristematic zones at the expense of lamina tissues. Further tissue specific biochemical responses to water-deficit stress in *F. novae-zelandiae* have been investigated. Changes in water-soluble carbohydrates (WSC) were monitored over a 49-day dry-down period (decline in soil water content from 30% to 4%) in consecutive leaf segments comprising the leaf base (meristem region), elongation zone, the enclosed and exposed lamina, as well as basal sheath segments from the two next oldest leaves. In fully hydrated leaf tissues polymers of fructose (fructans) were the main WSC present and were mainly low molecular weight fructans of the inulin and neokestose series with the average degree of polymerization (DP) of fructan pools from 6 to 9. The highest fructan concentrations were present towards the leaf base. Fructan concentrations decreased over the course of the dry-down, although remained significantly higher in the meristem region of the tiller base with respect to any other tissue, until tissue water content fell below 45%. By day 49 of the dry-down period, the average DP of the fructan pool in tissues was from 3 to 5. Sucrose content increased in each tissue during the course of the dry-down, and was highest at the leaf base, where a concentration of $200 \mu\text{mol g}^{-1}$ dry weight was measured after 49 days of dry-down.

The negative correlation between fructan and sucrose content, which indicates an inter-conversion dependent on tissue water content, suggests that, in this species, fructans serve as a carbohydrate storage pool, while sucrose stabilises the meristem during extreme water deficit.

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